REMARKS

This Amendment is being filed in response to an Office Action mailed on August 28, 2002. Applicants respectfully request reconsideration of the present application in light of the Amendments above and remarks below.

By this Amendment, Applicant has amended the claims, specifically, Applicant has amended claims 40, 43, 44, 47, 48, 50, 51, 53, and 56 , and Applicant has cancelled claim 49 without prejudice or disclaimer. Consequently, claims 40-48 and 50-73 remain in the present application. The nature of these amendments is to clarify the wording thereof in an effort to conform the interpretation to Applicant's intent. Thus, the amendment should not be understood to be a narrowing of the statement of the invention, nor an abandonment of any subject matter not originally claimed. Applicant asserts that no new matter is added by this amendment.

Prior to addressing the rejections, Applicant takes this opportunity to set forth the following brief remarks in connection with the invention, which relates to a catalyst and methods of making the catalyst.

One of the important characteristics of catalysts in accordance with preferred embodiments of the invention is the presence of "stable oxygen defects". One advantage to catalysts in accordance with preferred embodiments of the invention is having catalytic activity from visible light. Methods in accordance with the invention involve plasma and vacuum treatments of the catalyst material to improve its properties. In addition to characterizing catalysts in accordance with the invention by their enhanced properties, catalysts in accordance with the invention can be identified and characterized by certain spectral properties.

Thus, as set forth in the Specification, the degree of stable oxygen defects can be characterized by measuring, from a spectral analysis, the area assigned to the 1s oxygen atom and comparing it to the area assigned to the 2p titanium atom. As indicated in the Specification, ratios of 1.99 and below are indicative of a high oxygen defect rate and enhanced catalytic activity. (See application, page 6). Accordingly, improved results occur when the ratio has this value as now set forth more clearly in the independent claims.

It is also important to have oxygen defect stability. To characterize this property, the application discusses measuring the ratio (O1s/Ti2p) after a week or 6 month's exposure to the air. (p. 7).

For example, referring to Example 4 on page 27 of the Specification as well as to Figures 2 and 3 of the Drawings, comparison of ESR spectra between the catalyst of this invention and a commercially available anatase TiO_2 was demonstrated. The commercially available anatase TiO_2 with a ratio of 2.00 does not satisfy the requirements of the claimed invention as demonstrated, and further to the discussion with respect to stable oxygen defects of semiconductors of the prior art of record, it is asserted from the data of Example 4 that the semiconductor taught by the prior art of record would not satisfy the requirements and therefore the advantages of the claimed invention. Clearly, the Examples provided in the Specification provide evidence of the advantages of the claimed catalyst with ratios of 1.99 and below, compared to conventional catalysts with ratios of 2.

Turning now to the Office Action, the Examiner has withdrawn claims 74-87 from consideration as being directed to a non-elected invention. Applicant respectfully traverses that withdrawal and respectfully requests that the Examiner reconsider his position with regard to the

withdrawn claims. However, if the Examiner stands by his withdrawal, Applicant hereby reserves the right to pursue withdrawn claims 74-87 in a divisional patent application directed at the withdrawn claims.

The Examiner rejected claims 43-44, 47, 48, 51 and 53 "under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention." The Examiner bases the rejections on numerous antecedent basis and lack of clarity citations.

Turning to the rejections based on the prior art, the Examiner rejected claims 40-49 under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 5,872,072 to Mouri et al. and rejected claims 50-73 under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,989,648 to Phillips in view of '072 to Mouri et al. Applicant respectfully traverses each of these rejections.

In view of the amendments to the claims as well as the remarks provided herein, Applicant respectfully submits that claims 40-48 and 50-73 in the present application are in condition for allowance.

Claim Rejections under 35 U.S.C. §112, Second Paragraph

As to the Examiner's rejection of claim 43 for the phrase "those patterns" lacking antecedent basis or as being unclear as to what is being referred to. Applicant respectfully traverses that rejection. Applicant's amendment to claim 43 has provided antecedent basis by first reciting "patterns", and, thus, Applicant has obviated the Examiner's rejection. Accordingly, Applicant respectfully requests withdrawal of that rejection.

The Examiner also rejected claim 44 for the phrase "the peak area obtained" lacking antecedent basis. Applicant respectfully traverses that rejection. Applicant's amendment to

claim 44 has provided antecedent basis by first reciting "a peak area obtained", and, thus, Applicant has obviated the Examiner's rejection. Accordingly, Applicant respectfully requests withdrawal of that rejection.

The Examiner also rejected claim 44 for the term "that assigned" being unclear as to what is being referred to. Applicant respectfully traverses that rejection. Applicant's amendment to claim 44 has more clearly defined Applicant's invention by reciting "a peak area obtained by X-ray photoelectron spectroscopy assigned", and, thus, Applicant has obviated the Examiner's rejection. Accordingly, Applicant respectfully requests withdrawal of that rejection.

The Examiner has also rejected claim 47 for the phrase "the ESR", lacking antecedent basis. Applicant respectfully traverses that rejection. Applicant's amendment to claim 47 has provided antecedent basis by first reciting "an ESR", and, thus, Applicant has obviated the Examiner's rejection. Accordingly, Applicant respectfully requests withdrawal of that rejection.

The Examiner also rejected claim 48 for the term "which" being unclear as to what is being referred to. Applicant respectfully traverses that rejection. In order to advance the prosecution of the pending application, Applicant has accepted the Examiner's suggestion by replacing "which yields" with "said signal yielding", and, thus, Applicant has obviated the Examiner's rejection. Accordingly, Applicant respectfully requests withdrawal of that rejection.

The Examiner also rejected claim 51 for the phrase "the vacuum degree" lacking antecedent basis. Applicant respectfully traverses that rejection. Applicant's amendment to claim 51 has provided antecedent basis by reciting "a vacuum degree", and, thus, Applicant has obviated the Examiner's rejection. Accordingly, applicant respectfully requests withdrawal of those rejections.

The Examiner also rejected claim 53 for the phrase "the treatment system" lacking antecedent basis. Applicant respectfully traverses that rejection. Applicant's amendment to claim 53 has provided antecedent basis by reciting "a treatment system", and, thus, Applicant has obviated the Examiner's rejection. Accordingly, applicant respectfully requests withdrawal of that rejection.

Claim Rejections under 35 U.S.C. §102

The Examiner has rejected claims 40-49 under 35 U.S.C. §102(e) as being anticipated by U.S. Patent 5,872,072 to Mouri ("Mouri"). Applicant respectfully submits that Mouri neither teaches nor suggests Applicant's invention, as recited by the claims presently in the application.

Turning now to the rejected claims, claim 40 is rejected by the Examiner under 35 U.S.C. § 102(e) as being anticipated by Mouri. The Examiner asserts that Mouri discloses catalytic compositions comprising titanium oxide (see abstract and col. 5, lines 41-42), as semiconductors (see abstract), exhibiting NOx reduction (see col. 13, lines 43-44), and having activity under ultraviolet, sunlight and fluorescent wavelengths (see col. 12, lines 1-11). In contrast, claim 40, as amended, discloses a catalyst having activity under an irradiation of visible light in a wavelength region from about 400 to 600 nm, comprising titanium dioxide having stable oxygen defects and exhibiting NOx oxidation activity under the irradiation of a visible light at least in the wavelength region of from about 400 to 600 nm; and the titanium dioxide further having a peak area ratio (O1s/Ti2p) of a peak area obtained by X-ray photoelectron spectroscopy assigned to the 1s electrons of oxygen (O1s) participating in the bonds with titanium to a peak area obtained by X-ray photoelectron spectroscopy assigned to the 2p electrons of titanium (Ti2p) of 1.99 or lower.

The feature of claim 40 is that titanium dioxide has stable oxygen defects and a ratio of a peak area obtained by X-ray photoelectron spectroscopy assigned to the 1s electrons of oxygen participating in the bonds with titanium to a peak area obtained by X-ray photoelectron spectroscopy assigned to the 2p electrons of titanium (O1s/Ti2P) of 1.99 or lower.

The peak area ratio (O1s/Ti2p) represents a degree of oxygen defects of the titanium dioxide and the important feature of claim 40 is that the peak area ratio (O1s/Ti2p) is 1.99 or lower. Detailed definition of peak area ratio (O1s/Ti2p) in claim 40 is only for the purpose of clear definition of the ratio but not for insisting that the ratio is special.

As the Examiner pointed out in the Official Action, oxide semiconductors such as titanium dioxide exhibiting property of semiconductor may have oxygen defects inherently.

However, the amount or level of oxygen defects of the titanium dioxide exhibiting property of the semiconductor is substantially smaller than the oxygen defects of the titanium dioxide of the present invention. This is demonstrated in the specification of this application. See, e.g., Example 1 (pages 21-23, especially page 22, lines 14-22) of the Specification.

In this example, a powder of an anatase titanium oxide was plasma treated and peak area ratios (O1s/Ti2p) of the resulting treated powder and the starting material were measured. The peak area ratio (O1s/Ti2p) of the resulting treated powder was 1.91 and that of the starting material, anatase titanium oxide, was 2.00. Similar results are also illustrated in Examples 2 and 3 (pages 23-26) of the Specification.

The starting material, anatase titanium oxide, was a commercially available titanium oxide used for a photocatalyst. However, this photocatalyst only exhibits UV activity but does not exhibit visible light activity like the photocatalyst of this invention. It can be assumed that the starting

material may have oxygen defects but the level of the oxygen defects is quite small and therefore, peak area ratio (O1s/Ti2p) was 2.00.

Applicant asserts that the titanium oxide taught in Mouri '072 also has peak area ratio (O1s/Ti2p) of 2.00 and if the Examiner maintains this rejection, he should demonstrate that the titanium oxide taught in Mouri '072 exhibits peak area ratio (O1s/Ti2p) of 1.99 or lower.

Accordingly, Applicant thus respectfully submits that claim 40 is not anticipated by Mouri et al. under 35 U.S.C. §102(e). Applicant respectfully submits that Mouri does not disclose the novel features recited by claim 40. Nor would those features be obvious from a hypothetical combination of Mouri and any other prior art reference of record in the present application, or from a hypothetical combination of Mouri and the knowledge of a person of ordinary skill in the art. Accordingly, Applicant respectfully requests that the Examiner withdraw the rejection to claim 40 under 35 U.S.C. § 102(e) based on Mouri et al.

Claims 41-43 depend from claim 40, and define the invention with greater particularity. Applicant respectfully submits that Mouri does not disclose the novel features recited by claims 41-43. Nor would those features be obvious from a hypothetical combination of Mouri and any other prior art reference of record in the present application, or from a hypothetical combination of Mouri and the knowledge of a person of ordinary skill in the art. Accordingly, Applicant respectfully submits that claims 41-43 are patentable in their own right, as well as for depending from allowable claim 40. Accordingly, Applicant requests that the Examiner withdraw the rejection to claims 41-43 under 35 U.S.C. § 102(e) based on Mouri et al.

Independent claim 44 is also rejected by the Examiner under 35 U.S.C. § 102(e) as being anticipated by Mouri et al. The Examiner asserts that Mouri discloses catalytic compositions

comprising titanium oxide semiconductors, exhibiting NOx reduction, and having activity under ultraviolet, sunlight and fluorescent wavelengths. In contrast, claim 44, requires a catalyst having activity under an irradiation of visible light, the catalyst comprising titanium dioxide having stable oxygen defects and a peak area ratio (O1s/Ti2p) of a peak area obtained by X-ray photoelectron spectroscopy assigned to the 1s electrons of oxygen (O1s) participating in the bonds with titanium to a peak area obtained by X-ray photoelectron spectroscopy assigned to the 2p electrons of titanium (Ti2p) of 1.99 or lower (emphasis ours). Accordingly, Applicant thus respectfully submits that claim 44 is not anticipated by Mouri et al. under 35 U.S.C. §102(e), and further respectfully submits that the Examiner's rejection of that claim in view of Mouri et al. should be withdrawn.

Claims 45-46 depend from claim 44, and define the invention with greater particularity. Applicant respectfully submits that Mouri does not disclose the novel features recited by claims 45-46. Nor would those features be obvious from a hypothetical combination of Mouri and any other prior art reference of record in the present application, or from a hypothetical combination of Mouri and the knowledge of a person of ordinary skill in the art. Accordingly, Applicant respectfully submits that claims 45-46 are patentable in their own right, as well as for depending from allowable claim 44.

Claims 47-48 are also rejected by the Examiner under 35 U.S.C. § 102(e) as being anticipated by Mouri et al. Referring to Example 4 on page 27 of the Specification as well as to Figures 2 and 3 of the Drawings, comparison of ESR spectra between the catalyst of this invention and a commercially available anatase TiO_2 was demonstrated. The commercially available anatase TiO_2 does not satisfy the requirement of claim 47 as demonstrated, and further

to the discussion with respect to stable oxygen defects of semiconductors taught by Mouri et al, it is asserted from the data of Example 4 that the semiconductor taught by Mouri et al would not satisfy the requirements of claim 47. Incorporating all previous arguments as well as the arguments presented above, Applicant asserts that claims 47-48 are not anticipated by Mouri et al. under 35 U.S.C. §102(e), and further respectfully requests that the Examiner withdraw the rejection to claims 47-48 under 35 U.S.C. § 102(e) based on Mouri et al.

In conclusion, Applicant finds no teaching or suggestion in the prior art of a peak area ratio (O1s/Ti2p) of 1.99 or lower, as recited by Applicant's existing claims. Thus, Applicant respectfully submits that the Mouri et al patent does not disclose each and every aspect of the claimed invention either explicitly or impliedly, and further respectfully submit that the Mouri patent is not a proper 35 U.S.C. §102(e) reference. See, e.g., MPEP §706.02(a).

Claim Rejections under 35 U.S.C. §103

Claims 50-73 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,989,648 to Phillips in view of U.S. Patent No. 5,872,072 to Mouri et al. Applicant respectfully traverses this rejection, and submits the following arguments in support thereof.

As mentioned above, Mouri '072 fails to teach that the titanium oxide exhibits peak area ratio (O1s/Ti2p) of 1.99 or lower. Thus the combination of Philips '648 and Mouri '072 never teach the method for production of the photocatalyst of the present invention.

Applicant respectfully submits that none of the references relied upon by the Examiner in rejecting the claims of the present application, considered alone or in any hypothetical combination (between and among each other or with the knowledge of a person of ordinary skill in the art), teach or suggest Applicant's invention, as recited by the claims of the present application.

Applicant respectfully requests reconsideration of the present application in view of the amendments to the claims as well as in light of the remarks provided herein.

Pages 15-17 of this Amendment, titled VERSION WITH MARKINGS TO SHOW CHANGES MADE, indicate the changes made to the Claims in accordance with this Amendment.

Early and favorable consideration of the present application in view of the amendments to the claims and remarks provided herein is respectfully requested. If the Examiner is not in a position to allow all claims as presently amended, the Examiner is urged to call the undersigned attorney at 212-806-5400.

Any additional fees or charges required at this time and in connection with the present application are hereby authorized to be charged to Deposit Account No. 19-4709.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please substitute claims 40, 43, 44, 47, 48, 50, 51, 53, and 56 as provided below, for claims 40, 43, 44, 47, 48, 50, 51, 53, and 56 currently in the present application. Please cancel claim 49 in the present application without prejudice or disclaimer.

40. (Twice Amended) A catalyst having activity under an irradiation of visible light in a wavelength region from about 400 to 600 nm, comprising titanium dioxide having stable oxygen defects and exhibiting NOx oxidation activity under the irradiation of a visible light at least in the wavelength region of from about 400 to 600 nm**; and said titanium dioxide further having a peak area ratio (O1s/Ti2p) of a peak area obtained by X-ray photoelectron spectroscopy assigned to the 1s electrons of oxygen (O1s) participating in the bonds with titanium to a peak area obtained by X-ray photoelectron spectroscopy assigned to the 2p electrons of titanium (Ti2p) of 1.99 or lower**.

43. (Twice Amended) The catalyst according to Claim 40, comprising titanium dioxide that is characterized by an X-ray diffraction (XRD) pattern that is substantially free from patterns other than ~~those~~ patterns assigned to anatase type titanium dioxide.

44. (Twice Amended) A catalyst having activity under an irradiation of visible light, said catalyst comprising titanium dioxide having stable oxygen defects and a peak area ratio (O1s/Ti2p) of a peak area obtained by X-ray photoelectron spectroscopy assigned to the 1s electrons of oxygen (O1s) participating in the bonds with titanium to ~~the~~ **a** peak area

obtained by X-ray photoelectron spectroscopy assigned to the 2p electrons of titanium (Ti2p) ~~is~~ **of** 1.99 or lower.

47. (Twice Amended) A catalyst having activity under an irradiation of visible light, the catalyst comprising titanium dioxide having stable oxygen defects and yielding a signal having a g value of from 2.003 to 2.004 in ~~the~~ **an** ESR measured in darkness at 77K under vacuum, and the catalyst also yielding a signal higher in intensity when measured at least under the irradiation of light in the wavelength region of from 420 to 600 nm at 77K in vacuum.

48. (Amended) The catalyst according to Claim 47, wherein a signal assigned to Ti^{3+}, ~~which yields~~ **said signal yielding** a g value of 1.96 when measured by ESR in darkness at 77K in vacuum, is substantially not observed on said catalyst.

50. (Twice Amended) A method for producing a catalyst comprising ~~an oxide semiconductor having stable oxygen defects~~ **titanium dioxide having stable oxygen defects and a ratio of a peak area obtained by X-ray photoelectron spectroscopy assigned to the 1s electrons of oxygen participating in the bonds with titanium to a peak area obtained by X-ray photoelectron spectroscopy assigned to the 2p electrons of titanium (O1s/Ti2p) of 1.99 or lower** and having activity under an irradiation of a visible light, said method comprising treating ~~the oxide semiconductor~~ **the titanium dioxide** with hydrogen plasma, characterized by performing said treatment in a state substantially free from an intrusion of air into a treatment system.

51. (Twice Amended) The method for producing a catalyst according to claim 50, wherein said treatment is performed in a tightly sealed system and said state substantially free from the intrusion of air into the treatment system is a state in which ~~the~~ **a** vacuum degree inside the tightly sealed system takes at least 10 minutes to make a change of 1 Torr.

53. (Twice Amended) A method for producing a catalyst comprising ~~an oxide semiconductor having stable oxygen defects~~ **titanium dioxide having stable oxygen defects and a ratio of a peak area obtained by X-ray photoelectron spectroscopy assigned to the 1s electrons of oxygen participating in the bonds with titanium to a peak area obtained by X-ray photoelectron spectroscopy assigned to the 2p electrons of titanium (O1s/Ti2p) of 1.99 or lower** and having activity under an irradiation of a visible light, said method comprising treating ~~the oxide semiconductor~~ **the titanium dioxide** with a plasma of rare gas, and performing said treatment in a state substantially free from an intrusion of air into ~~the~~ **a** treatment system.

56. (Twice Amended) A method for producing a catalyst comprising ~~an oxide semiconductor having stable oxygen defects~~ **titanium dioxide having stable oxygen defects and a ratio of a peak area obtained by X-ray photoelectron spectroscopy assigned to the 1s electrons of oxygen participating in the bonds with titanium to a peak area obtained by X-ray photoelectron spectroscopy assigned to the 2p electrons of titanium (O1s/Ti2p) of 1.99 or lower** and having activity under an irradiation of visible light, comprising the step of introducing ions of a rare gas on at least a portion of the surface of ~~the oxide semiconductor~~ **the titanium dioxide** by means of ion implantation.